VERY SHORT ANSWER TYPE QUESTIONS

Q. 1. What do you know about 'telemetry'?

Ans. Telemetry is a science of measuring at a distance.

Q. 2. Give types of telemetry.

Ans. 1. Analog and digital telemetry.

2. According to the signal.

3. According to the channel used.

Q. 3. Enlist two major telemetry systems.

Ans. 1. Hydraulic and pneumatic.

2. Electrical and electronic.

This may be sub classified as

(a) Loud line telemetry.

(b) Radio telemetry.

Q. 4. Write two lines about telemetry.

Ans. Telemetry consists of

(1) Transmitter

(ii) Receiver

(iii) Channel (Connecting the above 'two').

Q. 5. What is voltage telemetry?

Ans. In this, the measure is transmitted as a function of a.c. or dc voltage.

Q. 6. Give types of dc telemetry.

Ans. (a) Voltage telemetry.

(b) Current telemetry.

(c) Position telemetry.

Q. 7. Give types of ac telemetry?

Ans. It may be “land line” or “Radio” telemetry.

Q. 8. Define modulation.

Ans. This is an important process of radio (wireless) communication, in which we modify “carrier” according to the signal.

Q. 9. What is the need of modulation?

Ans The signal is modulated to raise its strength, so that it can travel to large distances.

Q. 10. Enlist types of modulations.

Ans. (1) Amplitude modulation

(ii) Frequency modulation

(iii) Phase modulation

(iv) Pulse modulation

(v) Digital modulation

(vi) Multiplexing.

Q. 11. What is amplitude modulation?

Ans. In this amplitude of the carrier is varied (modulated) according to the signal keeping frequency and other parameters of the carrier as constant.

Q. 12. What is frequency modulation?

Ans. In this, frequency of the carrier is varied according to the signal

Q 13. What is phase modulation?

Ans. In this, phase of the carrier is varied according to the signal

Q.14. What is sampling?

Ans. Sampling is the process of taking periodic samples of the signal and these samples are transmitted By this process multiplexing and pulse modulation transmissions are carried over.

Q 15. What is a pulse?

Ans. A pulse is a voltage or current wave, changing abruptly and, which may or may not repeat itself.

Q. 16. Define pulse modulation. Give its types.

Ans. In this, some parameter of tram of pulse is varied according to the signal It may of the following types

(i) Pulse amplitude modulation (PAM)—Jn this amplitude of the carrier pulse is changed by the modulating signal pulse keeping width and other parameter of the carrier pulse constant

(ii) Pulse width (or according to the amplitude of the signal duration) modulation (P W M or P D M)—In this, the width (or duration) of the carrier pulses is changed by the modulating signal pulse.

(iii) Pulse position modulation (PPM)—In this, the position (or time) of the carrier pulse is changed advanced (or delayed) The amplitude and width of the carrier maintained constant.

(iv) Digital pulse modulation-The mostly used digital pulse modulation is pulse code modulation (PCM).

In PCM, the signal is coded. Generally binary code (0,1) is used. The signal is 'coded' and transmitted. At the receiver it is decoded.

Q. 17. What is multiplexing?

Ans. This is the technique of sending more than one signals simultaneously over a single channel. There are two types

1. Time division multiplexing (T.D.M.)—In this, channel is shared between various signals on the basis of time division.

2. Frequency division multiplexing (FDM)-In this, channel is shared by various signals on the basis of frequency division.

Q. 18. Explain power line carrier communication (PLCC).

Ans. The PLCC is the technique of sending signal (message) through high tension lines of 66 kV or above.

Q. 19. Explain the term 'Telemetry'.

Ans. The 'Telemetry' means measurement at a distance (tele + metery). The term involves conversion of a quantity into a suitable signal, the transmission of that suitable signal over a proper channel and its recon version into a display which may be recorded or viewed graphically or may be stored.

Q. 20. Briefly classify the Telemetry systems.

Ans. The telemetry system can be classified.

(i) According to characteristic of the signal i.e. voltage, current frequency, pulse.

(ii) According to analog and digital signal.

(iii) According to the physical connection between transmitter and receiver i.e. 'channel' which may consists of 2, 3 or 4 wires.

(iv) According to other channels such as telegraph, telephone, radio, microwave etc.

Q. 21. Enlist two major telemetry methods.

Ans. The telemetry method depends upon the type of data to be transmitted and the distance.

(i) Hydraulic and pneumatic methods are adopted for short distances.

(ii) Electrical and electronic methods can be used for long distances.

Q. 22. Enlist various methods of telemetry.

Or

Give complete classification of telemetry systems.

Ans. The telemetry systems are classified as

1. Land line Telemetry

(a) Voltage telemetry

(h) Current telemetry—Basic system, motion balance system and force balance system.

(c) Position telemetry, Basic system, Bridge type and synchro type.

2. Radio (Frequency) telemetry:

(a) Amplitude modulation (AM) telemetry

(b) Frequency modulation (FM) telemetry

(c) Pulse modulation (PM) telemetry

(d) Pulse amplitude modulation (PAM) telemetry

(e) Pulse code modulation (PCM) telemetry

T.D.M. and F.D.M.

Q 23 What are the two basic requirements of landline telemetry ? Give its advantages and disadvantages.

Ans. (a) The two basic requirements of landline telemetry are

(i) Economy

(ii) Reliability

(b) The advantages of landline telemetry are

(i) Simplicity of the setup

(ii) Space and weight are of no considerations

(c) The disadvantages of landline telemetry are

(i) All the transmission link distortions are introduced in the system

(ii) In dc telemetry the effect of thermo-electric emf (thermocouple) is dominant

(iii) The frequency response is limited

(iv) The multiplexing is not possible

Q 24. Write a note on General Telemetry system .

Ans. A general electrical telemetry system is shown in fig. 1. It has three basic components

(i) Transmitter

(ii) Receiver

(iii) The channel interconnecting the above two

The quantity to be measured called (measurand) is detected and the output electrical signal is transmitted through the channel At receiving end the electrical signal is received and converted back into usable form as indicated, recorded or displayed by the end device.

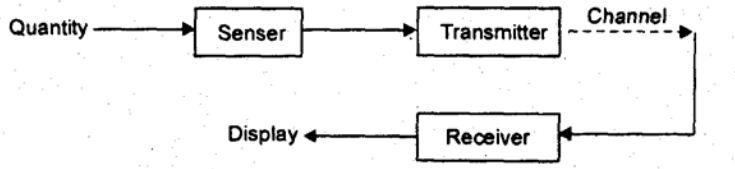

Fig. 1

Q. 25. Write a note on voltage telemetry system.

Ans. The voltage telemetry system transmits the measured variable as a function of ac or dc voltage.

A slide wire potentiometer is used in series with a battery. The sliding contact is made by a Bourden pressure tube (or thermocouple, differential transformer, tachometer. The channel consists of a pair of wires connected to a null or balance type meter, or recorder. In this case a potentiometer calibrated in N/m2 has been used. The system is used up to a distance of 300 m. (Fig. 2).

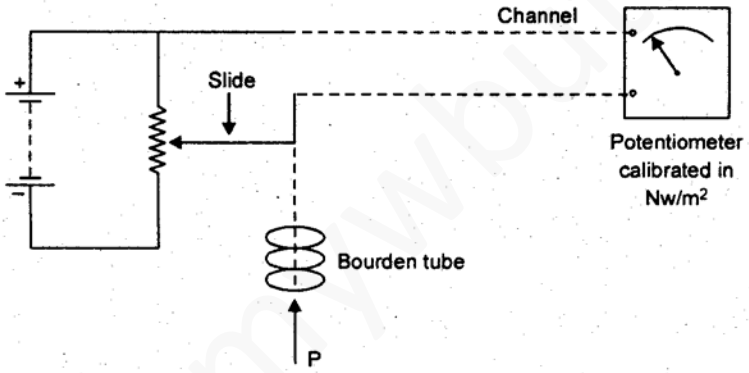

Fig. 2

The system requires a higher Signal/Noise ratio The channel should be protected

against outside interference. The system in best suited when many input voltages are

to be connected in series

This method is however not much in use.

Q. 26. What is the major difference between current and voltage telemetry?

Ans. The major difference between the two system is that in current telemetry, the current in the communication line is maintained at a measurable value, irrespective of

the line conditions.

But, in the voltage telemetry a very small current is drawn from the circuit, so that resistive drop (IR drop) in the communication line is negligible. At the receiving end therefore the voltage is measured by a “null” method to keep the line current zero at the time of measurement.

Q. 27. What are DC and AC telemetry?

Ans. 1. DC Telemetry. in this syctem-th-sign1 istranmifted-through-a-te1emetry channel utilizing direct transmission via cables for conveying)signal. The DC tele is also called “Landline telemetry”. The examii are

- **Q.** Voltage telemetry

(ii) Current telemetry

(iii) Position telemetry.

2. A.C. Telemetry. In this, alternating quantities are transmitted by using telemetry circuits such as telephone cables, transformers and amplifiers.

The AC telemetry is used both for ‘landline’ and radio frequency techniques. The data available (current or voltage) is very weak, hence it is modulated by an ac carrier wave generate by an oscillator.

Q. 28. What are the merits and deverits of current telemetry system Vis-à-vis voltage telemetry system?

Ans. The merits of current telemetry system as compared to voltage telemetry system are given below:

(i) The current telemetry system can develop higher voltages than the voltage telemetry system.

(ii) These are more immune to the effects of thermal and inductive voltage in the connecting loads.

(iii) The system can be used by adding output of several transmitters operating several receivers at a time.

(iv) The speed of response is almost instantaneous.

(v) It is easy to detect an open circuit in the channel, as the transmitter deliver some definite minimum current even when the measured variable is at its lowest limit.

(b) Demerits of current telemetry are:

(i) The current telemetry is more susceptible for errors due to leakage currents to the ground.

(ii) Current transmitters are more costly then voltage transmitters.

SHORT & LONG ANSWER TYPE QUESTIONS

Q. 29. Explain principle of position telemetry.

Ans. A position telemetry system transmits and reproduces the easuxe yatiable

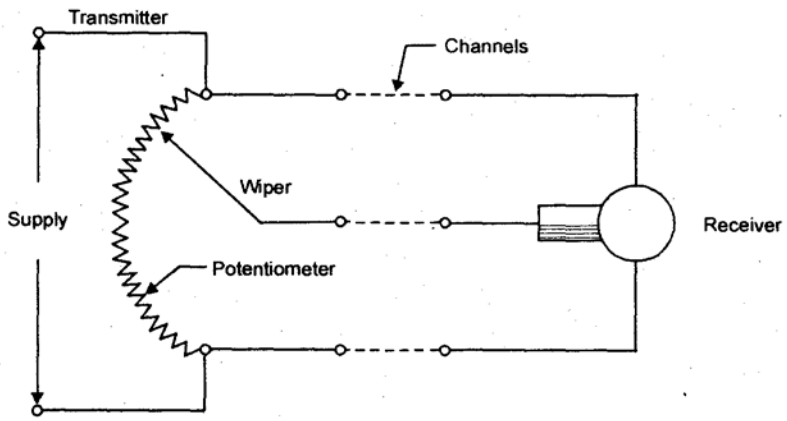

Fig. 3

By positioning variable resistor or other components in a bridge circuit form so as to produce proportional changes at both the ends (transmitter and receiver).

In this system, the transmitter adjusts the relation between the signal in correspondence to the measurement. The receiver converts the signals into displacement to represent the measurement. In this way the operation is based on comparison of two or more electrical quantities (voltage current etc.). So the system requires at least 3 conductors between the two ends. The fig. 3 shows the principle.

Out of three, one conductor is taken common. The value of one quantity is adjusted with the help of the potentiometer/rheostat potential divider. There are two methods of position telemetry.

(i) Bridge type position telemetry.

(ii) Position telemetry using synchros. This is also known as balanced. Bridge method.

Q. 30. Explain Balance Bridge position telemetry.

Ans. The Fig. 4 shows Bridge type position telemetry system. The circuit operates on the principle of wheat stone bridge.

There are two potentiometers. One at transmitting end and other at receiving end. Both are energized by a common supply. The slide contact at the transmitting end is positioned by Bourdon tube, when pressure is applied on the tube.

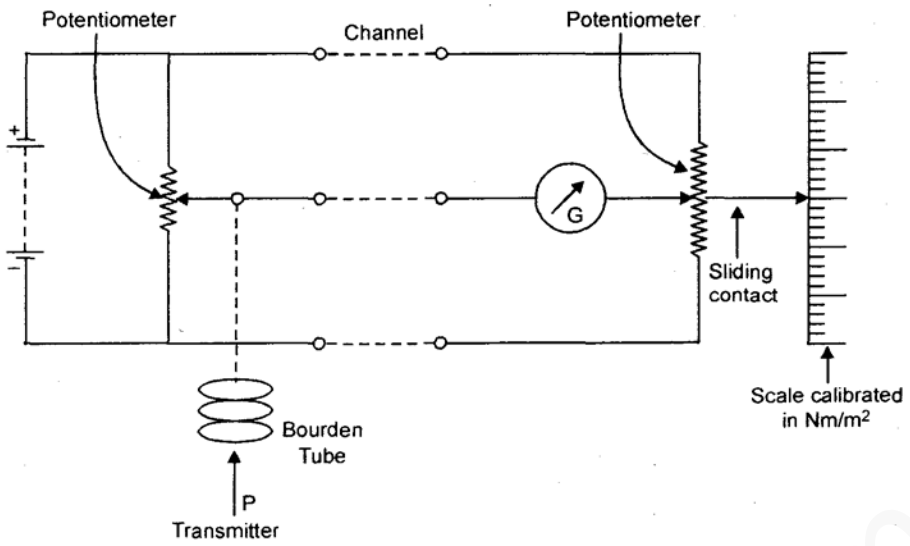

Fig. 4

If sliding contact at the receiving end is positioned, till the galvanometer indicates zero; the position of the contact will assume the same position as the contact at the transmitter end. The receiving end sliding contact moves the pointer, which indicates the pressure to be measured needless to tell that the scale is calibrated in Nm/rn2.

Q. 31. Define modulation. Explain its need.

Ans. (a) MODULATION-The process of changing some characteristic (amplitude, frequency, phase, etc) of carrier by the signal (audio or video) is called 'modulation'.

'Modulation' means modification, variation or change. We modify the carrier according to the signal and hence the name. This is an important process of wireless communication.

(ii) NEED FOR MODULATION-In carrier (wireless) transmission, modulation is a necessity. This is explained below:

(a) The first and the foremost reason is that the original sound produced by microphone (or video camera in case of video signal) is very weak and it has very low frequency The energy contained by the signal is proportional to its frequency Thus due to losses in energy, the signal will die after some

distance Moreover, it cannot travel long distances. Therefore, the low frequency signal is made to sit on high frequency carrier' Such an arrangement enables the signal to travel long distance before it dies out At the receiver the signal is separated out and the carrier is grounded

---

Q 32 What are the various types of modulation?

Ans Modulation is an important process in all wireless (carrier) communications In this, the signal is superimposed on a high frequency carrier wave. Some characteristic (amplitude, frequency, phase, etc.) of the carrier wave is changed in accordance with the instantaneous value of the signal. A sine wave may be represented by

$$e = E_m \sin(\omega t + \phi)$$

where

e = instantaneous value of modulated wave

maximum amplitude

w = angular velocity

• = phase relation

Accordingly, modulation is of three types (see the above equation)

1. Amplitude modulation.

2. Frequency modulation.

3. Phase modulation.

However, the complete classification of modulation processes are given below:

1. Amplitude modulation (AM)

(a) single side band AM (SSBAM)

(b) Double side band AM (DSBAM)

(c) Frequency division multiplexing (FDM)

In India, for sound, amplitude modulation is used.

2. Frequency modulation (FM)

In India for television signals, frequency modulation is used.

3. Phase modulation.

4 Pulse modulation (used in telephone and telegraphy)-these may be

(a) Pulse amplitude modulation (PAM)

(b) Time division multiplexing (TDM)-used in long play records.

(c) Pulse time modulation (PTM)

(d) Pulse division multiplexing

(e) Pulse code modulation (PCD)

5. Digital modulation (DM)-They may be

(a) Differential PCM (DPCM)

(b) Adoptive PCM (ADPCM)

(c) Data modulation (DM)

(d) Adoptive data modulation (ADM)

Note: (a) The modulations may also be:

(i) Analog modulation

(ii) Digital modulation

(b) The amplitude modulation is often referred as linear modulation. The frequency and phase modulation are known as non ironer, angular or exponential modulation While there may be many forms of exponential modulations but only two i.e. frequency and phase modulations are practical. In particular, both linear as well as non linear modulations are continuous wave (CW) type modulations.

Q. 33. (a) Define sampling.

(b) How electronic sampling is done?

(c) Define multiplexing.

(d) Write a note on time division and frequency division multiplexing.

Ans. (a) Sampling. In electronic communication, sampling is the process of taking periodic samples of the wave form to be transmitted and then transmitting these samples. If enough samples are sent, the complete wave form can be received at the receiver.

The concept of sampling can be explained by the following example

Suppose a factory has four process vats, each having a thermometer which is to carefully monitored temperatures. This can be done in two ways.

(a) To receive continuous data of thermometer four workers are required. Since any change in the temperature will be gradual, this will not be economical.

(b) The sampling data will be more economical as only one worker can monitor the data of all the four thermometers. If this single worker can take the data samples faster, than the thermometer can change, the same effect of continuous sampling can be achieved at a reduced cost (In this case one fourth):

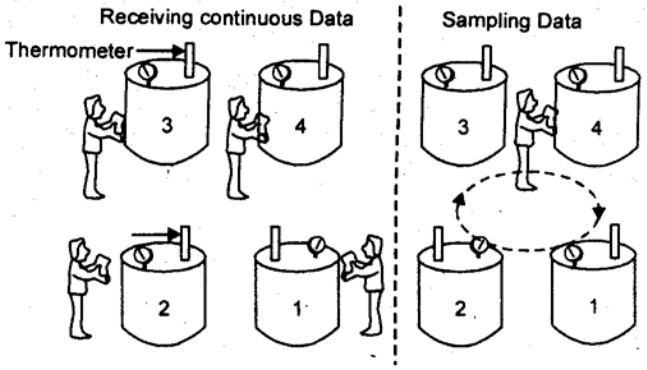

Fig. 5

The situation is similar to transmitting and receiving in pulse electronic communication. Clearly, sampling data, rather than continuous monitoring produces more efficiency and makes it possible to send more than one information on one single carrier. Note that only one transmitter and one. receiver shall be needed.

(b) Sampling Electronic Signals. Let us think that three different signals are to be sent over a signal wire. By sampling technique. this can be done as shown in Figure. The switch of transmitter as well as of the receiver are changing in such a manner that both attain same position at a time i.e. when transmitter is at position A, the receiver should also be at A and so on. The recorders should be of slow response time i.e. much less than the sampling rate.

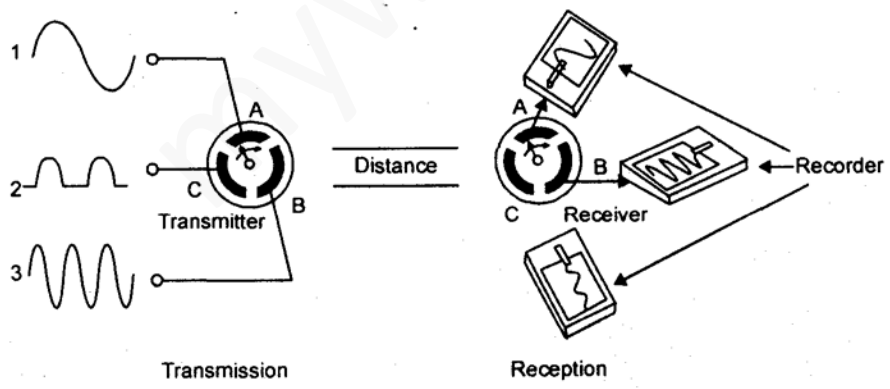

Fig. 6

(c) Multiplexing. The transmitting many signals in a single channel through sampling is known as multiplexing.

This is a process used for transmitting telephonic messages or signals. It is a process of transmission of more than one signals together and simultaneously through the same line. This increase the handling capacity of the line.

Multiplexing may be of the following types

1. Time division multiplexing

2. Frequency division multiplexing.

(d) Time Division Multiplexing (TDM) : T pulse generally narrow in width and separation between them is larger. This fact is utilized in this multiplexing. The by an other signals. One line is assigned to channels turn by turn. In low speed TDM, rotatisiches (mechanical in nature) used in transmitter as well as in receive synchronized with one another.

Number of aid to the transmitter switch are separated by the receiver switch. In high speed TDM, electronic switches replace the mechanical switches. If the speech wave is sampled at a frequency greater than the highest frequency present in the speech, we get an output sample wave as shown (Fig. 7a) in which the speech signal is present and same may be obtained at the receiver.

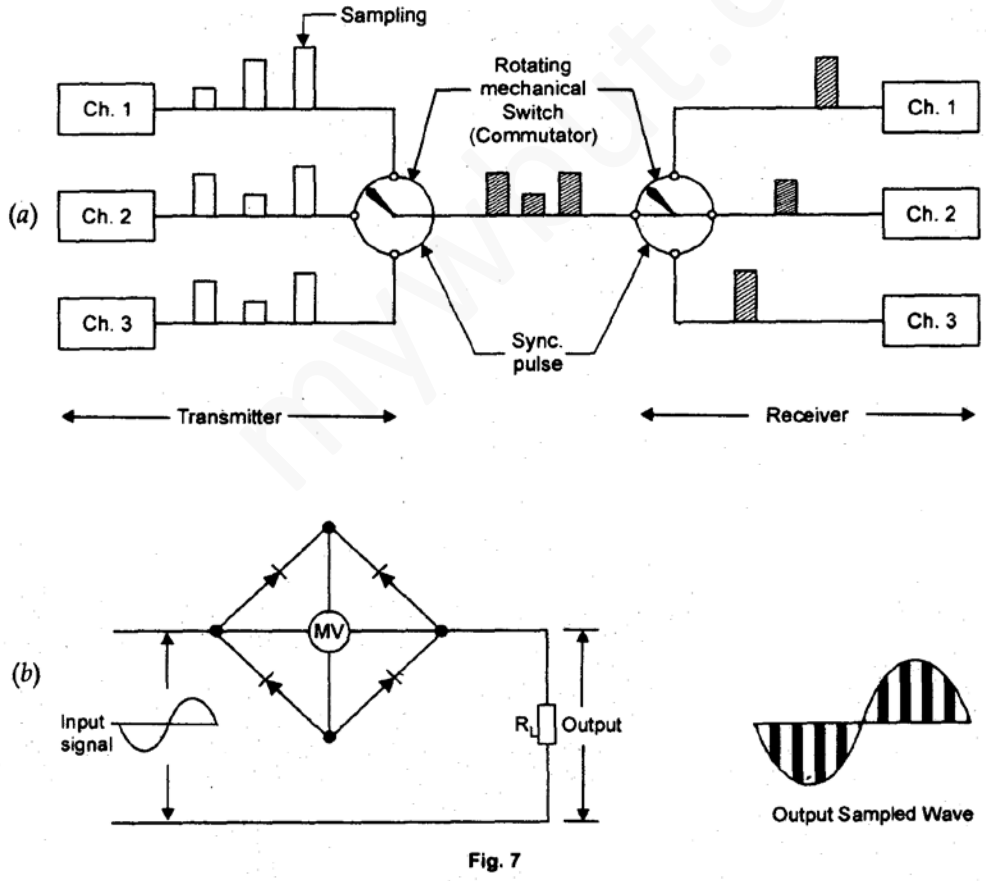

Fig. 7

For generating such a wave at the transmitter a Multi vibrator (MV) producing 10 kHz carrier wave with a bridge rectifier circuit is used. Across the load RL the sample wave is obtained (Fig. 7b). At the receiver the same circuit detects the sample wave across its load, provided both the circuit (at transmitter as well as at receiver) work in synchronism. If two persons are provided with such a circuit they can hear each other. Moreover a number of signals can pass through the same transmission line.

(e) Frequency Division Multiplexing (FDM) : This is also known as carrier

Telephone system, carrier frequency is modulated by the such signals

asamodulat4v,ve, we get original carrier and is side bands which carry the similar sent the receiver of original speech signal is detected or demodulated using different carrier frequencies we get different side bands of different frequencies and therefore any number of signals can be transmitted simultaneously through the same line. Similarly, the signals can be received at the receiver by using different filter circuits.

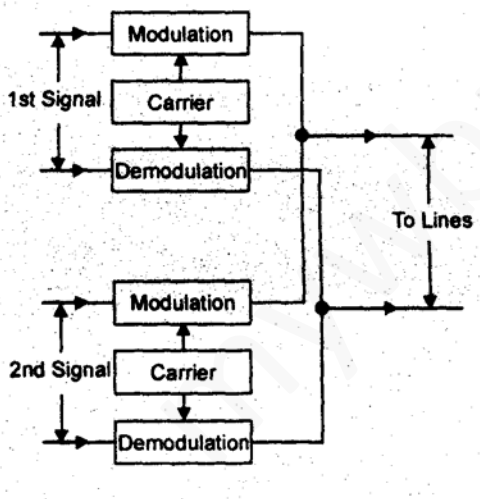

Fig. 8

The Fig. 8 shows simplified diagram of an electronic telephones exchange using

FDM. Only two signals have been shown but any number of signals can be through a

pair of lines. In this system, each channel is assigned a carrier frequency which is modulated by the channel signal. The modulated carriers then travel through the line simultaneously.

Q. 34. What are the various channels used in telemetry?

Ans. The most common transmission channels in telemetry are cables and radio links. However optical, ultra sonic, microwave links and power lines are also employed.

The wires or cables are used for transmitting industrial plants (and power stations)

to control monitoring points.

Radio links are usually employed for a distance more than one kilometer.

Frequency modulated (FM) radio, optical or ultrasonic methods are used upto 50

meters.

The microwave channels employ bands of 890 MHz to 30 GHz, however initial cost of this method is very high.

The power lines of 66 KV and above are employed for transmission of information (about faults etc.) between substations. This is known as power line carrier communication (PLCC).

The various channels are described below:

1. Wire/cable—For land line telemetry, wires/cables are used. The wires may be overhead or underground. The underground cables have the following advantages over overhead line.

(1) They do not suffer from problem of lightning etc.

(ii) The underground cables have many layers of insulation so they are free from many problems.

(iii) Their parameters (resistance, inductance and capacitances) remain almost unchanged.

2. Radio links—The radio channels employ R.F. waves and used for logic distances. This channels (or medium) is also employed, when information is being transferred between moving vehicles such as missiles. To have more than one channel, multiplexing techniques are employed.

3. Microwave channel—The microwave is a special case of radio transmission. Several bands in the range of 890 MHz to 30 GHz have been allocated for microwave transmission.

The M-waves are beamed directly from one antenna to other antenna. The 'line of sight' is small, so intermediate 'repeaters' (stations) are set up at every 50 Km or so

throughout the entire route.

4. Power line carrier communication (PLCC)—When a fault occurs at a substation (or generating station) it must be conveyed immediately for repairs. If ordinary telephones are used for this purpose, it will be delayed as the lines remain engaged. For this purpose, power lines (66 kV and above) are used.

Q. 35. Write in brief about various current telemetry systems.

Ans. The current telemetry is almost same as the voltage telemetry.

In this system, value of current is adjusted in an extended circuit to correspond a measured quantity and this value of current is determined by an end device at a remote place.

Following current telemetry systems are used.

Basic current telemetry (Fig. 9). In this system (e.g. for measuring pressure) a slide wire is connected in series to a battery with the sliding contact positioned by a Bourdon pressure tube. Two wires as a medium are connected to end device which can measure the current. A milliammeter is calibrated in terms of Nw/rn2 is generally used as end device. This method is obsolete now as change in supply voltages causes serious errors.

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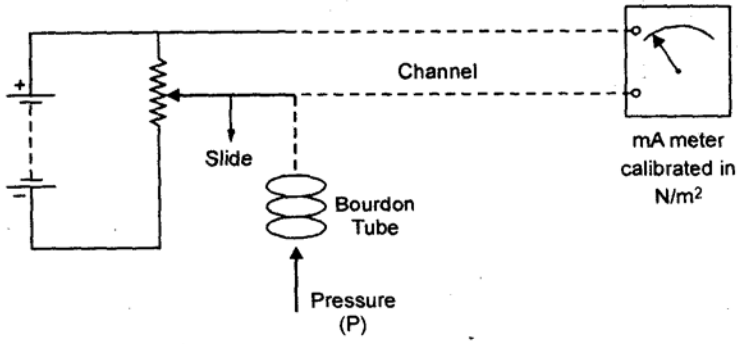

Fig. 9

2. Motion balance current telemetry (Fig. 10). In motion balance current telemetry sy3tem, the slide wire is replaced by an Inductive or capacitive position detector like LVDT (Linear Voltage Differential Transformer), which is an inductive transducer.

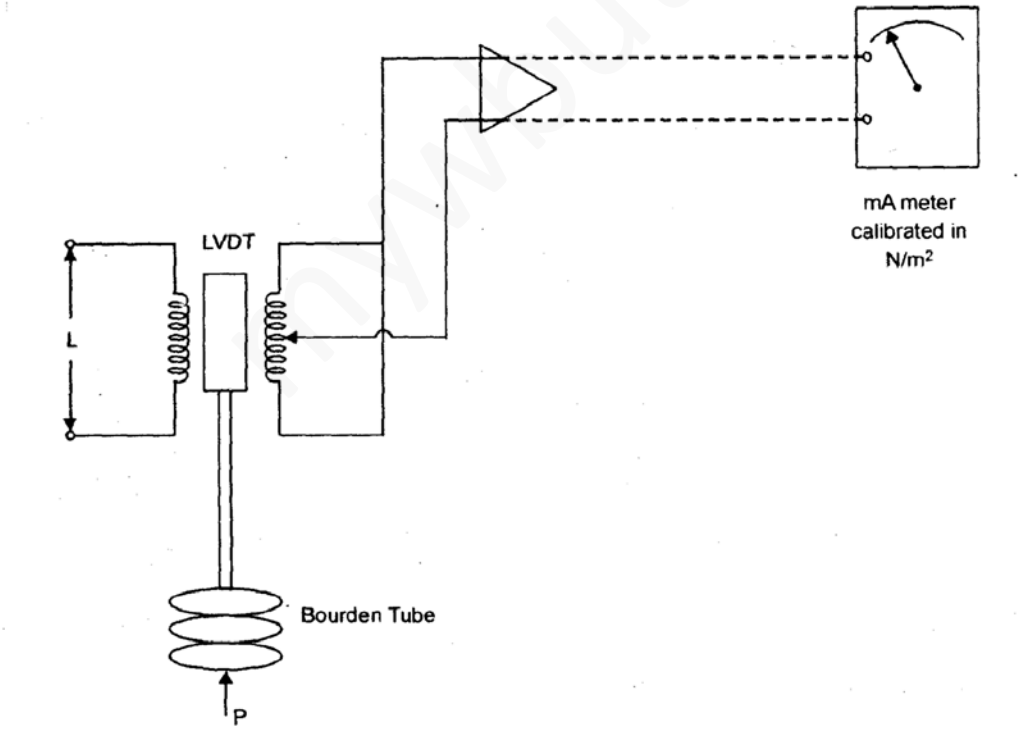

Fig. 10

The pressure acting on the Bourdon tube causes a displacement, which moves the core of the LVDT. This produces a voltage, which is amplified and rectified. This voltage produces a direct current of the order

of 10 to 20 mA in the channel and is measured by a dc millimetre at the receiving end. The millimetre is calibrated in Nw per m2.

Force balance current Telemetry (Fig. 11). In this system, a part of the current output is “fed back” to oppose the motion of the input variable. The system is operated by a Bourdon tube which rotates the “feedback force coil” that in turn changes the “flux linkage” between primary (F) and secondary (S) coils. The change in flux linkage varies the amplitude of the amplifier. The output signal is connected to the “feedback (FB) force coil” which produces force that opposes the Bourden tube input.

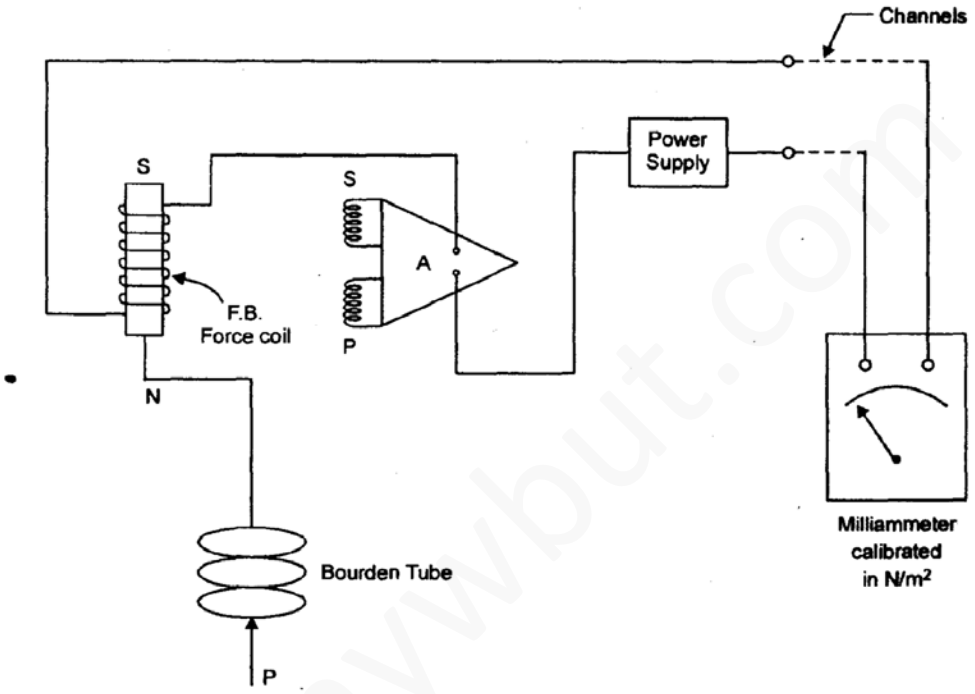

Fig. 11

The arrangement increases accuracy as smaller motions needed resulting in better linearity.

Q. 36. (a) What do you mean by synchros?

(b) Explain position telemetry using synchros?

Ans. (a) Synchro-A synchro is an electromagnetic transducer, which can convert angular motion of a shaft into electrical signal. There are two modes of synchro systems : control and error detector mode and torque transmission mode, usually the latter is used.

(b) Position telemetry using synchros—This uses synchro transmitter and receiver. This is a telemetry. The pure a.c. land line telemetry employs the transmiter and receiver in torque transmission mode. The system uses a pair of synchro transmitter and receiver. The rotors and stators of both are connected in torque transmission configuration. The input in this case is angular position of the synchro-transmitter. When rotors of transmitter and receiver are in the same position, the emf induced in both the stator F are equal and of the F.B. force coil are there is no current in the telemetry channel. When the rotors of transmitter is rotated, different emfs are induced in the stators of transmitter and receiver, this unbalanced in emf sketch current through the channel. The flowing of current in the receiver's stator produces a torque on the receiver's rotor, till it occupies the same position as the rotor of the transmitter, in other words a condition of synchronism is established.

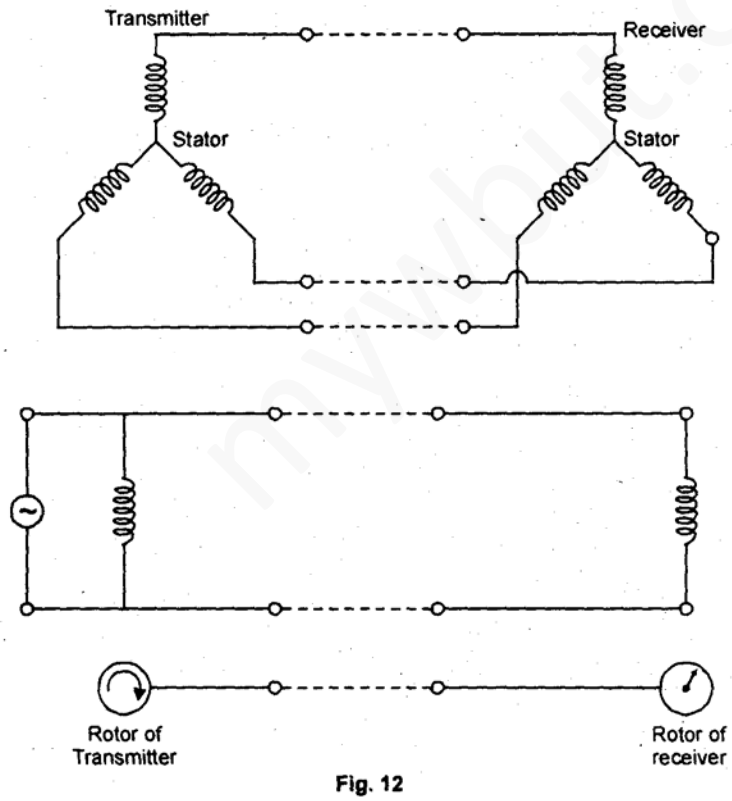

Fig. 12

A simple position in the receiver's rotor indicates the position of synchronisation. Three phase synchronous motors may be used as transmitter and receiver. The

“ratio systems” like this are useful for a distance of less than few kilometres. The transmitters are usually inexpensive and need only low forces from the primary measuring elements. Many systems can be used with either low cost deflect ional or servo actuated receivers if higher torque is required.

Q. 37. Write a note on Radio Frequency (RF) telemetry.

Ans. In this method there is no physical link between transmitter and receiver. The link between transmission station (where the actual measurements are carried out) and the receiving station (where the measurable quantity is measured recorded and information used for control purposes) can be established only through radio links.

The RF telemetry is suitable for distances over 1 km. Certain RF spectrum have been allocated for the telemetry and microwave links above 5 MHz. The radio waves at these frequencies travel in straight line and the system requires repeater stations at every 50 km on the route.

The Fig. 13 shows the basic arrangement for radio frequency telemetry.

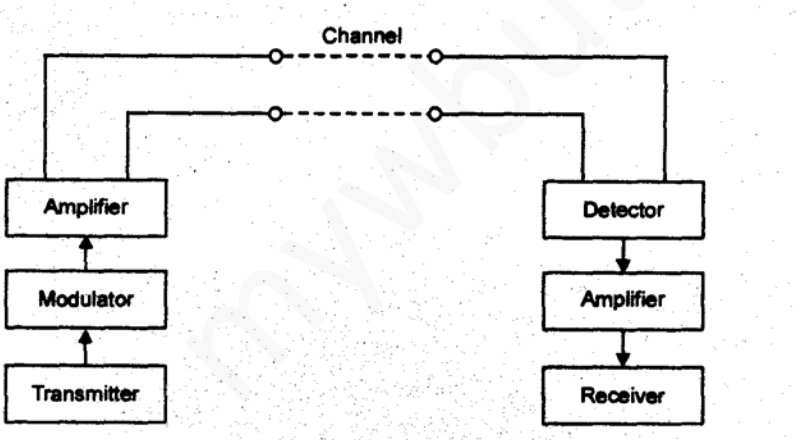

Fig. 13

At transmitter the signal is modulated. This can be amplitude (frequency) pulse modulation etc. The modulated signal is amplified and sent through the channels e.g. microwave channel. At the receiver the signal is deflected amplified and measured e.g. the receiver may have a frequency meter calibrated in units corresponding to the measured.

Q. 38. Explain frequency modulated (FM) telemetry system.

Ans. The FM telemetry is an earliest technique of mixing (multiplexing) data channels.

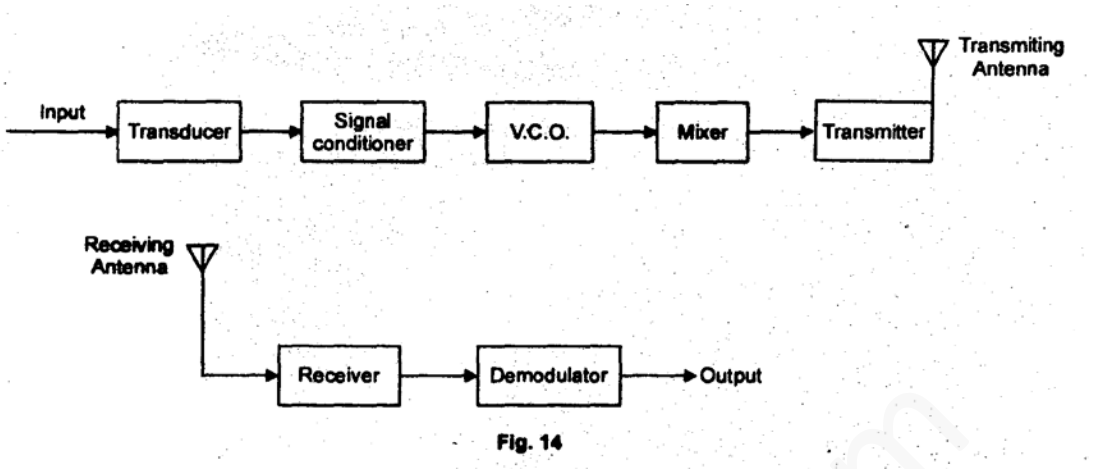

Fig. 14

At the transmitting end, signal is given to transducer and then to the signal

conditioner. The output then modulates the frequency of a voltage controlled oscillator (V.C.O.). The output of V.C.O. is mixed and transmitted through transmitting antenna.

At the receiving end, the signal is received through the receiving antenna and demodulated. The demodulator is tuned with the frequency of input. As the value

changes at the source the output of the demodulator changes accordingly.

Q. 39. Enlist advantages and disadvantages frequency modulated (FM) telemetry over amplitude modulated (A.M.) telemetry.

Ans. Advantages of F.M. telemetry

1. The transmitted power in F.M. is constant and is independent of the modulation depth, whereas in A.M. the power depends upon the modulation depth.

2. All the transmitted power in F.M. is useful, where as most of the A.M. power is not useful.

3. The F.M. reception is noise free, where as .A.M. reception is not so. The F.M. reception can be improved by using “amplitude limiter” or by increasing the “deviation”, this facility is not available in A.M.

4. There is lesser adjacent channel interference in F.M.

5. The F.M. broadcast happens in V.H.F. (very high frequency) and U.H.F. (ultra high frequency) bands, where less noise is present.

The A.M. broadcast happens in M.F. (medium frequency) and HF (high frequency) bands, where happens to be more noise.

Disadvantages of F.M. telemetry

1. About 10 times wider channel is required in F.M. as compared to A.M.

2. The F.M. equipment is complex and costly than the A.M. equipment.

3. The area of reception is much smaller in F.M. than in A.M.

Q. 40. What is a pulse? Define pulse modulation (P.M.).

Ans. (a) PULSE-A pulse is an abruptly changing voltage or current wave which may or may not repeat itself. The simplest non repective pulse is a stepped up voltage or current shown in Fig. 15 (a) which can be obtained by connecting a voltmeter across a battery through a switch and then suddenly closing the switch. The voltmeter will read zero upto a time when the switch is closed, where upon the voltage will suddenly rise to its maximum value and will stay there.

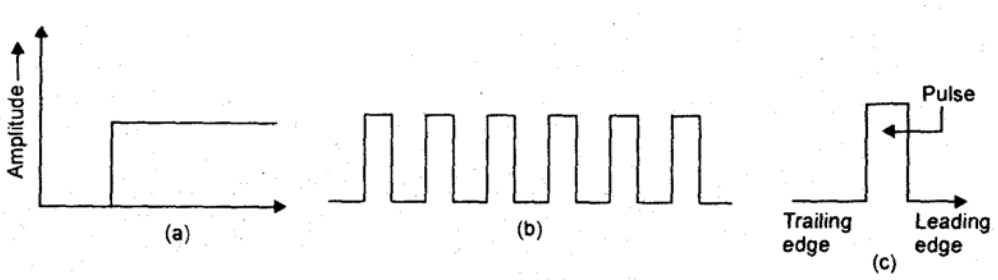

Fig. 15

The Fig (b) shows a repective pulse train and figure (c) shows a pulse with its

trailing and leading edge

(b) PULSE MODULATION-This may be defined as a modulation system in which some parameter of a train of pulse is varied in accordance with the instantaneous value of the modulating signal.

In this system, waveforms are sampled at regular intervals and the information is transmitted only at the sampling rate.

The parameter of the pulses which may be varied are amplitude, width or duration position or time etc.

Q. 41. Write briefly about various pulse (or impulse) telemetry systems.

Ans. In the conventional telemetry systems, the electrical signals are modulated and the magnitude may attain any value within the operating range, each representing the corresponding value of the signal under measurement. But in pulse telemetry, the transmitted variable signal is not an electrical quantity, but it is a function of time.

In pulse telemetry the pulse are generated which are either ON or OFF and actual amplitude of the pulse is not so important but beginning and finishing (termination) provide significant dimensions. The signals may be transmitted over long distance with more faithfulness fidelity compared to the conventional telemetry.

The important pulse (impulse) telemetry system are:

Pulse amplitude modulation (PAM) Telemetry—In this system, the carrier is modulated with pulses whose "heights" carry the information. The PAM system consists of a series of information pulse following a synchronising pulse. Each pulse is "amplitude modulated in proportion to the value of the magnitude of the quantity under measurement.

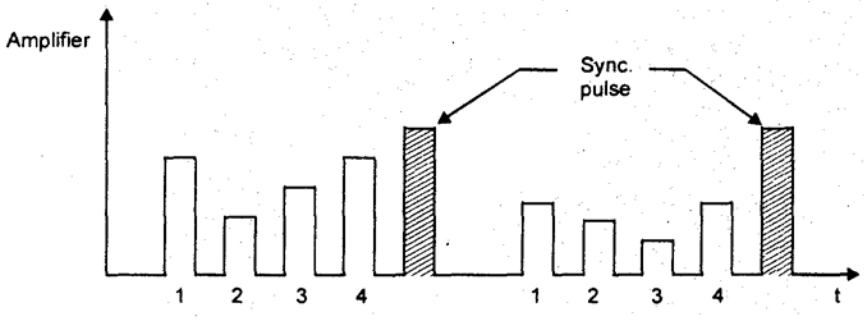

Fig. 16

From the Fig. 16 which shows amplitude Vs time chart for a pulse train it can be seen that each pulse has different amplitude (height) and represents amplitude of the corresponding signal. Also the pulse are equally spaced except for the synchronising (sync.) pulse which are inserted after regular gap.

Pulse duration modulation (PDM) Telemetry : It is also called pulse width modulation (PWM).

In this system, pulse are generated of same height or amplitude at a uniform rate. But duration width of each pulse is different and proportional to the existing amplitude of the measure and. See Fig. 17 Note that there is no synchronising pulse.

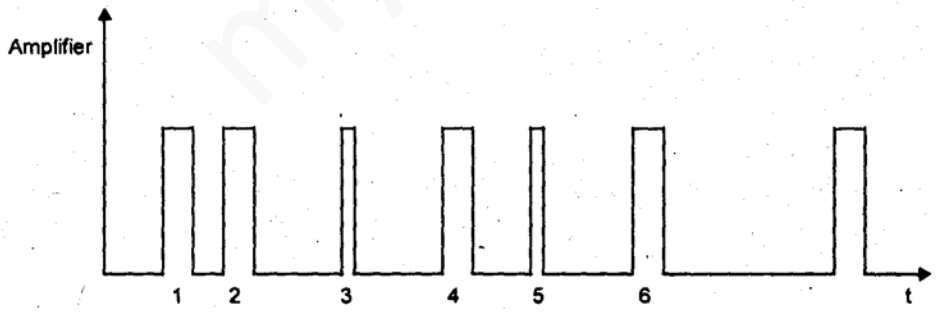

Fig. 17

The frequency of the pulse train is about 10 Hz for electronic transmitters. The transmission error is less than 1%.

3. Pulse position modulation (PPM) Telemetry : This system is almost similar to

PDM or PPM system except that a short pulse is used place of variable pulse width.

This pulse train is obtained by differentiating and then rectifying the PDM pulse train.

The power required in PPM is lesser (but with a wider band width) as compared to the PDM.

Pulse code modulation (PCM) Telemetry: It is digital telemetry system. In this system a train of pulses is generated in which presence (or absence) of each pulse represents the magnitude of the quantity "in code". The capacity of the system depends upon the bandwidth of the original signal.

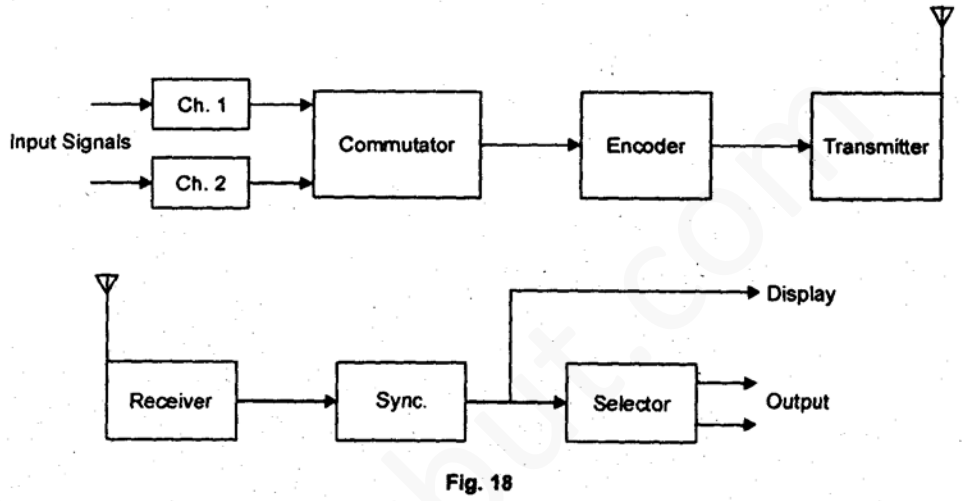

Fig. 18

The PCM system employs a seven digit code and the signal is transmitted using FM (frequency modulation). The least significant digit (LSD) is transmitted first.

The system is almost noise free and can be recorded as analog as well digital data and can also be displayed as directly fed into a computer. The Fig. 18 shows PCM telemetry (2 channels).

Q. 42. What is multiplexing-telemetry? Discuss the types.

Ans. (a) Multiplexing telemetry system is a method of transmitting more than one measurement signals at the same time over a single channels. When the distance increases between transmitting and receiving ends, the cost of using separate channel for each measurement (installation, maintenance, repair etc.) becomes quite uneconomical. It is also not feasible/economical to use different radio link for each channel, so multiplexing is the best choice.

(b) In multiplexing telemetry, the channel is shared between various measurements (quantities) either on the basis of time division or frequency division. So there are two types of multiplexing telemetry.

1. Time Division multiplexing (TDM) telemetry (Fig. 19): The TDM telemetry is adopted, where sampling at frequent time invervals is adequate to meet the frequency response of the quantities (measure ands) under measurement. In TDM, the samples of different quantities are transmitted one after the other on the same channel and the cycle is repeated again and again. It is important that the time period between two samples is sufficiently small such that the value of the quantity (being sent) does not change. In TDM some form of electronic switch (commentator) is used on both ends which operate in synchronistic. This is also important that transmitter of each quantity gets connected to the corresponding receiver after a Predetermined time.

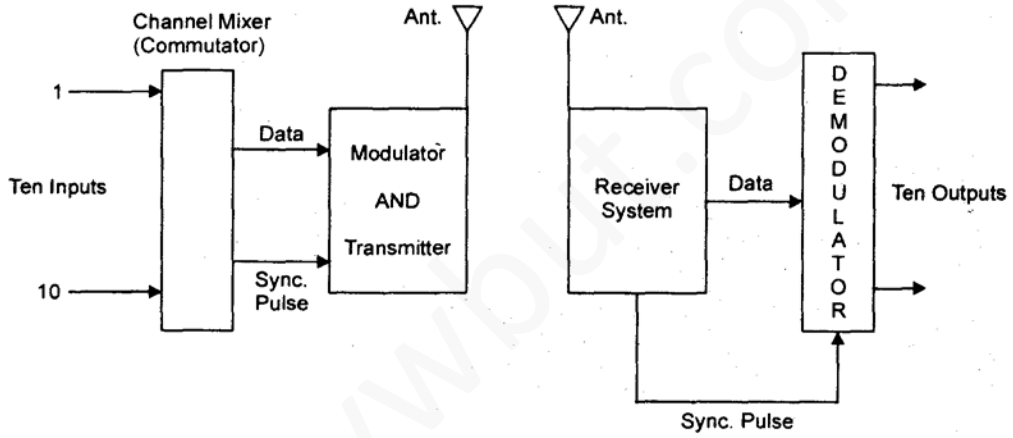

Fig. 19

2. Frequency division multiplexing (FDM) Telemetry: The FDM provides continuous intelligence transmission. The samples of different measurement (signals) are transmitted simultaneously on the same communication channel. The channel is shared among various measure ands on the basis of frequency division. The cycle is repeated again and again. Some form of electronic switch is used on both sides which operate in synchronism and the transmitter of each quantity gets connected to the corresponding receiver.

The Fig. 20 shows block diagram of FDM and Fig. 21 shows block diagram to explain a typical telemetry system employing T.D,M. as well as F.D.M.

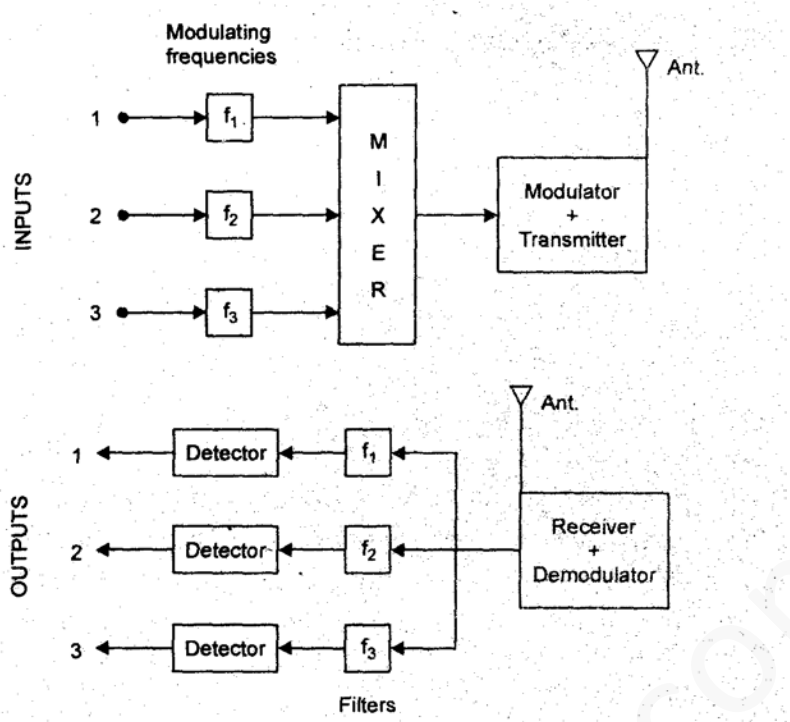

Fig. 20

In this.' typical circuit it has been assumed that all the telemetred variables do not change at the same rate e.g. if telemetry is used with pilot less aircraft, altitude and air speed change slowly, where as wing flulter change is rapidly. In such cases there is need for "narrowband " channels for handling slow changing variables and "wide band" channels for handling fast changing variables, obtained by a process known as "Sub commuting".

The process of "sub commutating consists of taking one of the wideband channels and subdividing it into several narrow band channels. Note that this system uses FDM in general and T.D.M. for sub commutated channels. It is also possible to use FDM for the sub commutated channels or TDM for both.

Also note that each channel passes through a balanced modulator (which ge input from a crystal oscillator), then through side band filter then to adder and amplifier. the amplified output is given to an L.C. oscillator (with automatic frequency control). The output is then passed through power amplifiers.

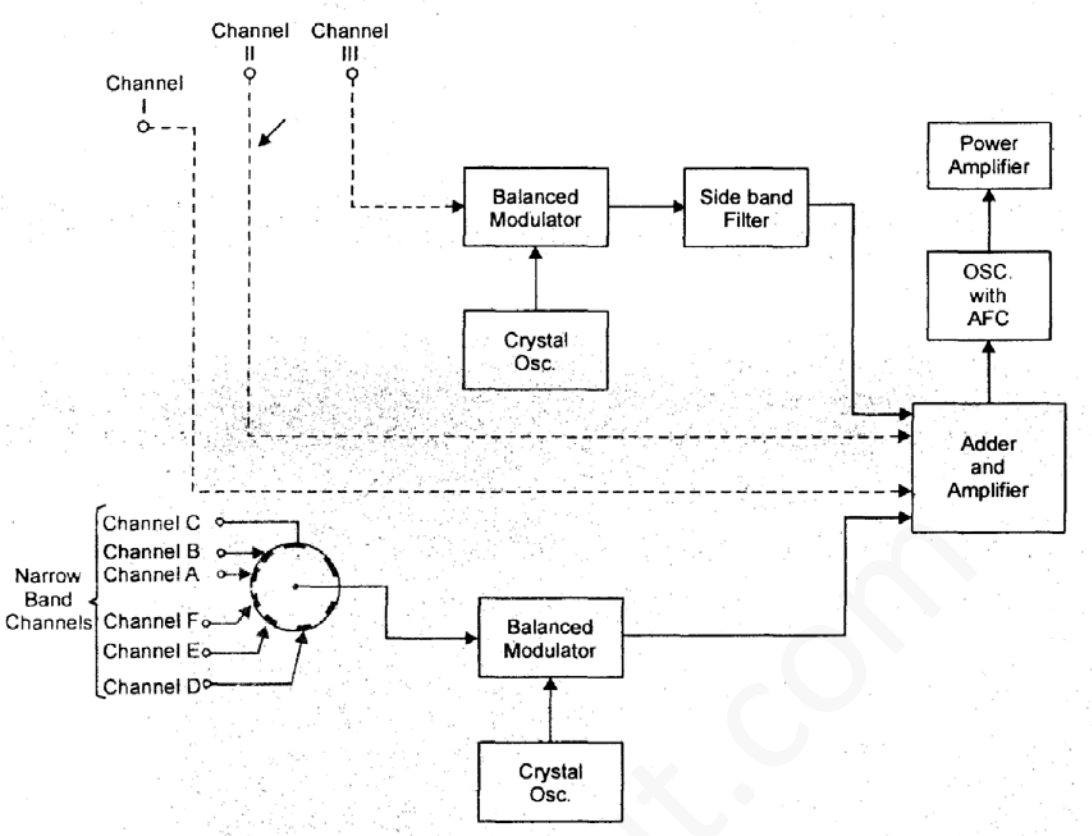

Fig. 21

In practice, several telemetry system are being used, as there standardisation in this field. The F.M./F.M frequency division multiplexing is most widely used and extended to PAM/FM/ FM, when sub commutating is required. It is reliable and flexible hut requires greater bandwidth (BW) and carrier strength than pure pulse system.

The systems such as PWM/FM, PAM/FM, PPM/AM and PCM/AM are also used. The last one has the advantage that if required, the sub commentator can be synchronised with the main commutate. Moreover it has simple circuitry and has low frequency drift.

Typical frequency bands (as per international regulation) for telemetry are 216 to 220 MHz and 2.2 to 2.3 GHz.

Q. 43. List various types of telemetry systems.

Ans. (i) Analog telemetry

(ii) Digital telemetry

(iii) Voltage telemetry

(iv) Current telemetry

(v) Position telemetry.

Q. 44. Write applications of telementry.

Ans. (i) Measurement from a distance.

(ii) For data transmission

Q. 45. What is difference between dc and ac telemetring systems?

Ans. In dc telemetry, the information is transmitted through cables. This is also

called “Land line telemetry”. The voltage, current and position telemetry are the examples.

In ac telemetry, alternating signal is transmitted through telephone cables using amplifiers etc. This is employed both for land line as well as for radio frequency techniques. The signals are also modulated.

Q. 46. What is Multiplexing?

Ans. The technique of transmitting more than one signals at the same time over a single interconnecting link is called multiplexing.

NUMERICAL PROBLEMS

Problem 1. A data signal having frequency component from zero to 1 kHz is to be transmitted using modulation. Find the minimum carrier channel bandwidth (BW) using the following modulations.

1. Amplitude modulation

2. Frequency modulation

3. P.C.M. (Pulse code modulation).

Sol. I.

In A.M., the minimum bandwidth of carrier channel is twice of the data. max. B.W. = 2 x 1 2 kHz Ans.

2. In F.M. the minimum B.W. of the carrier channel = 2 (6 + ft Suppose deviation =6 = 1.5 kHz.

= 2 (1.5 + 10) = 5 kHz Ans.

3. In P.C.M., the minimum B.W. of carrier channel n.f. Suppose 7 digit code is used, n = 7

B.W. n.f. = 7 x = 7 kl-Iz Ans.

Problem 2. A 6 channel 0 to 50 Hz telemetry system uses P.A.M. and P.C.M. system. What should be the lowest sampling rate.

Solution. The sampling rate should be

= 5 (No. of channels x frequency)

= 5 x 6 x 50 = 1500 samples per second Ans.

Problem 3. In an A.M. system, the carrier frequency is 100 MHz. The permissible V B.W. is ± 5 kHz. The signal, which modulates the carrier has a B.W. of 1 kHz. What are the number of channels for effacienct use of the media

Solution. The B W of the modulated carrier wave = 100 MHz ± I kl-Iz This B W is necessary to transmit 1 kHz data

We have permissible

B W = ±5 kHz out of which the signal occupies ±1 kHz only

So for the efficient use, it is possible to use ± 5 kHz bandwidth to transmit 1 kl-Iz data 5 times.

So we can transmit five 1 kHz data via 100 MHz modulated carrier. We can have 5 channels each transmitting 1 kHz.

Problem 4. The 21 data channels with sub carrier centre frequencies, ranging from 400 Hz to 165 kHz have been allocated for a F.D.M. telemetry. All have a frequency deviation of ± 7.5%. If modulating index is 5, find signal B.W. for channel 1 for a centre frequency of 165 kHz.

Solution.. Frequency deviation of channel 1

$$= \frac{7.5}{100} \times (165 \times 10^3) = 12.375 \text{ kHz}$$

$$\text{B.W. for the signal} = \frac{\text{deviation}}{\text{mod. index}} = \frac{12.375 \times 10^3}{5}$$

V = 2A75 kHz Ans.